Table 2. Awareness by COMs of "electromagnetic hypersensitivity" and number of calls received per week.

Country	No of replies a/	Awareness of the problem		Number of calls per week d/		
		Receive calls b/	Know of other centres c/	< 1/week	1-4/week	≥5/week
Austria	4	3	3	1	0	0
Denmark	13	6	5	10	0	0
Faroe Island	1	0	0	0	0	0
Finland	2	2	2	1	1	0
France	6	4	2	5	0	0
Germany	8	7	7	2	1	4
Iceland	1	1	1	0	0	0
Ireland	1	1	1	0	0	0
Italy	4	1	1	3	0	0
Norway	6	4	4	5	0	0
Sweden	8	8	8	6	2	0
The Netherlands	1	0	0	1	0	0
United Kingdom	7	3	3	2	0	0

Notes for Table 2. a/ Total number of replies, regardless of whether answers to these specific questions were given or not. b/ Number of COMs that have received questions or requests. c/ Number of COMs that knew of other centres that do. d/ Number of COMs replying within each category.

less. The number of COMs that received requests appear to vary considerably between countries, though. For Denmark, Italy and United Kingdom, the majority of the COMs that did reply did not receive requests, nor were they aware of other centres that did. The single answers received from COMs in the Faroe Islands and The Netherlands were likewise negative. In some contrasts, most replies from e.g. Austria, France, Germany, Norway and Sweden were affirmative in receiving requests and knowledge about other organisations that did. Similar responses (but based on fewer overall replies) were apparent from the other countries.

Table 3. Number of members of each SAG, and existence of other SAGs in the country.

Country	Number of replies	Only self aid group? a/		No of members
		Yes	No	
Denmark	1	1	0	75
France	2	0	1	4 and ? b/
Germany	3	0	3	20, 120 and 160
Ireland	2	0	2	3 and 350 c/
Norway	1	1	0	90
Sweden	1	1	0	1800

Notes for Table 3. a/ Number of SAGs in each response category. b/ No number given by one SAG. c/ Described as number of "contacts" by one SAG.

Concerning the SAGs, questions were asked about the number of members and if their group was the only one that they knew of in their country dealing with this problem. The replies are shown in Table 3. Again, the number suggest quite a

variation between different countries - but the limited number of countries for which we have identified SAG groups should be kept in mind.

The extent of the problem

Both COMs and SAGs were asked to give "your estimate as to the total number of such "cases" in your country", and also the "total number of such cases with severe handicap because of this". The replies were categorised in the following manner; <10, 10-100, 100-1 000, 1 000-10 000 and >10 000. The number of replies in the two extreme categories as well as the median responses are found in Table 4 and 5.

As seen in the median values presented in Tables 4 and 5, the largest estimated numbers were reported from Germany and Sweden. The proportion between the numbers reported from SAGs and COMs were about one order of magnitude or higher in the SAGs for most countries (except for Norway) with extreme differences noted between COM and SAG replies from Ireland. Considering the number of cases in relation to the populations, the ranking order of all countries were Sweden > Norway and Denmark > Finland > Germany > Ireland > Austria and The Netherlands > Italy and France > United Kingdom according to the median COM answers. For Sweden, the upper limit of the estimate is roughly corresponding to 0.1%. A similar ranking was apparent from the (fewer) SAG answers, with the exception of the ranking of Ireland and Norway; Ireland > Sweden > Denmark > Germany > France and Norway.

Table 4. COM estimates of the number of cases and severe cases of "electromagnetic hypersensitivity".

Country	No of replies a/	Estimates on no of cases b/			Estimates on no of severe cases b/		
		<10	Median b/	>10 000	<10	Median b/	>10 000
Austria	4	1	10-100	0	3	<10	0
Denmark	13	2	100-1 000	0	5	10-1 000	0
Faroe Island	1	-	-	-	-	-	-
Finland	2	0	10-1 000	0	0	10-100	0
France	6	0	10-100	0	3	<10	0
Germany	8	0	1 000-10 000	3	0	1 000-10 000	2
Iceland	1	-	-	-	-	-	-
Ireland	1	0	10-100	0	1	<10	0
Italy	4	0	10-100	0	3	<10	0
Norway	6	0	100-1 000	0	1	10-100	0
Sweden	8	0	1 000-10 000	2	0	100-1 000	0
The Nether-lands	1	0	10-100	0	1	<10	0
United Kingdom	7 d/	1	<10	0	1	<10	0

Notes for Table 4. a/ Total number of replies, regardless of whether answers to these specific questions were given or not. b/ Number of COMs that replied in the two extreme categories, and the median response from all COMs for each country. Note that two of the medians cover two categories (Denmark and Finland). d/ Only on questionnaire responded to these questions.

For the median estimated number of severe cases, similar patterns are seen, with the largest numbers being reported from Germany and Sweden (and from the Irish SAGs), and with more or less similar ranks between the relative number of severe cases in different countries as were seen for the cases. The main difference is that here, Germany has a similar rank as the Nordic countries. The proportions of cases to severe cases are about one order of magnitude or less, for both COMs and SAGs.

Table 5. SAG estimates of the number of cases and severe cases of "electromagnetic hypersensitivity".

Country	No of replies a/	Estimates on no of cases b/ <10	Median b/	>10 000	Estimates on no of severe cases b/ <10	Median b/	>10 000
Denmark	1	0	1 000-10 000	0	0	100-1 000	0
France	2	0	1 000-10 000	1	0	100-1 000	0
Germany	3	0	>10 000	3	0	>10 000	2
Ireland	2	0	>10 000	2	0	1 000-10 000 and >10 000	1
Norway	1	0	100-1 000	0	0	100-1 000	0
Sweden	1	0	>10 000	1	0	1 000-10 000	0

Notes for Table 5. a/ Total number of replies, regardless of whether answers to these specific questions were given or not. b/ Number of SAGs that replied in the two extreme categories, and the median response from all SAGs for each country. Note that one of the medians cover two categories (Ireland).

A general and important caveat for this section is that all numbers are based on estimates from some different organisations, and closer scrutiny of absolute numbers - beyond orders of magnitude - should be avoided. The relative comparisons between different European nations are - in our opinion - presumably more reliable and therefore interesting.

Concerning situations where problems appear

All COMs and SAGs were asked to reply to the question "to your knowledge, do most of the cases experience problems due to exposure at work-places, exposure at home or exposure outdoors or other non-work situations." They were also asked corresponding questions as to where the problems started. The COM replies are given in Table 6.

For the SAGs, the Danish, Norwegian and Swedish SAGs all replied "at work" to both questions, while all German and Irish SAGs specified "at home" being the most common situations where problems started and where they now appear. The French SAG reported both "at home" and "outdoors" as places for current problems to appear. As can be seen when comparing these replies to Table 6, is that while the Scandinavian and German SAG replies corresponded well with the COM replies, discrepancies were seen for the French and the Irish replies.

Table 6. Indications by COMs of the most common situation (work, home or outdoors) where problems appear and where the problems started.

Country	No of replies a/	Problems appear mostly b/ At work	At home	Outdoors	Problems started mostly b/ At work	At home	Outdoors
Austria	4	1	2	0	1	2	0
Denmark	13	3	1	2	3	0	2
Faroe Island	1	-	-	-	-	-	-
Finland	2	2	0	0	2	0	0
France	6	4	0	1	3	0	1
Germany	8	1	6	0	1	6	0
Iceland	1	1	1	0	-	-	-
Ireland	1	1	0	0	1	0	0
Italy	4	2	1	1	2	1	1
Norway	6	4	2	1	5	0	0
Sweden	8	7	0	0	8	0	0
The Netherlands	1	0	0	1	0	0	1
United Kingdom	7	1	1	0	1	0	0

Notes for Table 6. a/ Total number of replies, regardless of whether answers to these specific questions were given or not. b/ Number of COMs that reported the category as "most common" is given (more than one category were chosen in a few replies).

Again, geographical differences are apparent, with the Nordic countries (Denmark, Finland, Norway and Sweden) emphasising work situations (by both COMs and SAGs), while the German situation is more centred at home (again by both COMs and SAGs). For other countries, the replies appear mixed and somewhat uncertain. Two examples are France and Ireland, where centres of occupational medicine (COMs) favoured workplaces, whereas the SAGs did not.

Attributed sources

Both COMs and SAGs were asked to "indicate common sources of problems for the cases" - several sources could be given. Below, the replies in the category "very often" are given.

Among the COMs in countries in the continental part of Europe or the British Isles, there were several that reported various radiofrequency field (RF) equipment or installations as a "very often" reported source of the problems.

- Broadcasting stations, TV towers or telecommunication masts were the most commonly indicated RF sources, reported by COMs from France (2 of 6), Germany (5 of 8), Ireland (1 of 1) and Italy (1 of 4).
- Radar stations reported by France (3 of 6) and Germany (2 of 8).
- Mobile telephones were indicated by 4 of the 8 German COMs and by 1 of the 4 Italian COMs.
- Induction heaters and plastic welding were reported by France (1 of 6) and Italy (2 of 4).
- Microwave ovens were suggested by the reply of 1 of the 7 United Kingdom COMs.

The COMs in the Scandinavian countries did not report any RF equipment as a "very often reported source" except for one Swedish COM that indicated mobile telephones as such.

Among the SAGs, RF equipment or installations were reported to be a "very often reported source" as follows; broadcasting stations, TV towers or telecommunication masts were indicated by the Danish SAG, 2 of the 3 German SAGs and both Irish SAGs. Microwave ovens were reported by the Danish, 1 of the 2 French and 1 of the 3 German SAGs. Both French SAGs reported induction heaters and plastic welding, while mobile phones were indicated by 1 of the 3 German and 1 of the 2 Irish SAGs. Radar stations were reported by 1 of the 2 Irish SAGs. Again, Nordic SAGs (with the Danish exception above) did not report RF sources.

Concerning equipment emanating extremely low frequency (ELF) fields, power lines or transformer stations were the most common to report according to Austrian (3 of 4), Danish (1 of 13), French (2 of 6), German (4 of 8), Irish (1 of 1), Italian (2 of 4), Norwegian (1 of 6) and United Kingdom (1 of 7) COMs. It is noticeable that this source was not reported at all by the Swedish, Finnish and some other COMs. Electrical appliances at home were reported by 3 of 13 Danish, 2 of 8 Swedish and 1 of 8 German COMs. Electric wiring in houses and railways were reported by 3 of 8 and 2 of 8 German COMs, respectively, while electric welding was not reported by any COM. The reporting of ELF sources by SAGs was rather limited; electrical appliances at home were indicated by the Swedish SAG, while the French SAG marked all ELF sources except railways.

Among some "miscellaneous" equipment, light sources (fluorescent tubes and VDUs) were suggested as "very often reported sources" of the problems by primarily the Nordic COMs; VDUs were indicated by 2 of 13 Danish, both Finnish, 2 of 6 Norwegian, and all 8 Swedish COMs. In addition, 1 of the 8 German and 1 of the 4 Italian COMs also indicated VDUs. Fluorescent tubes were suggested by Denmark (1 of 13), Finland (1 of 2), Germany (1 of 8) and Sweden (2 of 8). Medical equipment such as NMR or diathermy was reported by the Irish COM.

The SAGs more generally did suggest both VDUs and fluorescent tubes as a source, apart from the German ones. The SAG from Norway did not report fluorescent tubes as a "very often reported source". Heavy machinery in the industry were reported only by one French SAG.

Commonly occurring symptoms

Each COM and SAG were asked to list the 5 most common symptoms "reported in connection with the use of electrical appliances or proximity to electric or magnetic field sources". The number of COMs and SAGs who reported a symptom in any of the 12 symptom groups are shown in Tables 7-10. These latter numbers should be regarded with some caution, as the number of symptoms from different groups are not readily comparable.

Table 7. Number of COMs reporting different types of symptoms.

Country	No of replies a/	Nervous system symptoms	Skin symp-toms	Hormonal/ metabolic disorders	General body symptoms	Cardio-vascular symptoms	Digestive problems
Austria	4	4	1	0	0	0	0
Denmark	4	3	1	0	1	0	0
Faroe Island	0	-	-	-	-	-	-
Finland	1	1	1	0	1	0	0
France	4	3	0	0	0	0	0
Germany	7	7	2	0	2	0	0
Iceland	1	1	1	0	0	0	0
Ireland	1	1	0	0	0	0	0
Italy	1	1	0	1	0	0	0
Norway	3	3	3	0	0	0	0
Sweden	7	7	7	0	7	3	0
The Nether-lands	0	-	-	-	-	-	-
United Kingdom	1	1	0	0	0	0	0
Total no of symptoms b/	-	73	21	1	8	4	0

Notes for Table 7. The number of COMs reporting any symptom in each symptom group is given. a/ Total number to this part of the questionnaire. b/ The total number of symptoms reported by all COMs - note that a single COM could report more than one symptom in each group.

Table 8. Number of COMs reporting different types of symptoms or conditions.

Country	No of replies a/	Ear, nose, throat problems	Eye symp-toms	Cancer	Allergy	Reproduc-tive or preg-nancy problems	Other problems
Austria	3	0	1	0	0	0	0
Denmark	4	0	0	0	1	0	1
Faroe Island	0	-	-	-	-	-	-
Finland	1	0	0	0	0	0	0
France	4	0	0	2	0	1	0
Germany	7	1	0	1	1	0	0
Iceland	1	1	1	0	0	0	0
Ireland	1	1	0	0	0	1	0
Italy	1	0	1	0	0	0	1
Norway	3	0	0	0	0	0	0
Sweden	7	0	1	0	0	0	0
The Nether-lands	0	-	-	-	-	-	-
United Kingdom	1	0	0	0	0	0	0
Total no of symptoms b/	-	3	4	3	2	2	2

(Notes, see next page)

Notes for Table 8. The number of COMs reporting any symptom in each symptom group is given. a/ Total number to this part of the questionnaire. b/ The total number of symptoms (or equivalent) reported by all COMs - note that one COM could report more than one symptom in each group.

It is readily apparent from a scrutiny of tables 7-10 that most COMs and SAGs have reported nervous system symptoms to be among the most common ones in relation to "electromagnetic hypersensitivity". This is consistently reported from all COMs and SAGs across Europe (with the exception of the Swedish SAG). The second most common group is that of skin problems - but here a rather clear geographical variation is seen; substantial reporting from the COMs of Finland, Iceland, Norway and Sweden, some limited reporting from Austria, Denmark and Germany, and none at all from COMs in other European nations. The limited number of SAG replies offered somewhat different geographical variations, see Table 9.

Table 9. Number of SAGs reporting different types of symptoms.

Country	No of replies a/	Nervous system symptoms	Skin symptoms	Hormonal/ metabolic disorders	General body symptoms	Cardio-vascular symptoms	Digestive problems
Denmark	1	1	1	1	1	1	1
France	2	2	1	0	1	0	0
Germany	2	2	0	0	0	0	0
Ireland	2	2	1	0	0	0	0
Norway	0	-	-	-	-	-	-
Sweden	1	0	1	0	0	0	0
Total no of symptoms b/	-	22	4	2	2	1	1

Notes for Table 9. The number of SAGs reporting any symptom in each symptom group is given. a/ Total number to this part of the questionnaire. b/ The total number of symptoms reported by all SAGs - note that one SAG could report more than one symptom in each group.

For other types of symptoms or reported conditions, most appear to be isolated reports from a few COMs or SAGs in only a few countries, with the possible exception of eye symptoms, general body symptoms such as overall tiredness or ear/ nose/throat problems which were reported from more than a few of the COMs and SAGs in one or two nations.

Table 10. Number of SAGs reporting different types of symptoms or conditions.

Country	No of replies a/	Ear, nose, throat problems	Eye symptoms	Cancer	Allergy	Repro-ductive or pregnancy problems	Other problems
Denmark	1	0	1	0	0	0	0
France	2	0	0	0	0	0	0
Germany	2	1	0	0	0	0	0
Ireland	2	1	0	0	0	0	0
Norway	0	0	0	0	0	0	0
Sweden	1	0	1	0	0	0	0
Total no of symptoms b/	-	2	2	0	0	0	0

Notes for Table 10. The number of SAGs reporting any symptom in each symptom group is given. a/ Total number to this part of the questionnaire. b/ The total number of symptoms(or equivalent) reported by all SAGs - note that one SAG could report more than one symptom in each group.

Accordingly, the following presentation of data will be centred on nerve system symptoms and skin symptoms. As seen in Table 11, where the types of nerve system symptoms are presented in more details, the most common ones to indicate as being common among cases of "electromagnetic hyper-sensitivity" are neurasthenic symptoms, followed by headaches - these were reported by a majority of the COMs and SAGs. For the other symptoms, a few additional but less clear observations can be made; Among Austrian and German COMs and SAGs, reports of all these types of nerve system symptoms occurred, with the single exception that no German SAG reported anxiety symptoms. In the Nordic country COMs, the emphasis appeared to be - among nerve system symptoms - on symptoms of neurasthenia, headaches and decreased arousal, whereas the Swedish SAG did not report any nerve system symptoms as being "very common". Replies from the other countries were scattered.

Skin problems were differentiated into objective, subjective and undefined. Almost all organisations who reported any skin symptoms, did report either subjective or undefined symptoms, the only exception being one Danish COM and one French SAG.

Table 11. Various nerve system symptoms reported by COMs and SAGs.

Country	No of replies a/	Sleep problems	Decreased arousal	Neuras-thenia	Stress, irritation	Anxiety	Head-aches
Austria/COM	3	2	1	2	2	1	1
Denmark/COM	4	0	2	3	0	0	0
-"- /SAG	1	1	0	1	0	0	0
Finland/COM	1	0	0	1	0	0	1
France/COM	4	0	0	2	0	0	1
-"- /SAG	2	1	0	0	0	0	2
Germany/COM	7	5	3	6	5	2	5
-"- /SAG	3	2	1	2	3	0	1
Iceland/COM	1	0	0	1	0	0	1
Ireland/COM	1	0	1	0	0	0	2
-"- /SAG	2	1	2	3	2	0	0
Italy/COM	1	1	0	2	1	1	1
Norway/COM	3	0	2	2	0	1	2
Sweden/COM	7	1	4	6	0	2	3
-"- /SAG	1	0	0	0	0	0	0
United King-dom/COM	1	0	0	3	0	0	1
Sum	-	14	16	34	13	7	21

Notes for Table 11. The number of symptoms reported by COMs or SAGs in each country is indicated. Note that one COM/SAG could report more than one symptom under each heading. a/ Total number of replies to this part of the questionnaire.

Concerning consequences for the afflicted individuals

Both COMs and SAGs were asked to indicate their appraisal as to the severity of the consequences of "electromagnetic hypersensitivity". Five alternatives could be marked by the notations "most", "several", "few" or "none", the alternatives being:

- Perceive fields or minor symptoms but do not suffer in any consequence in daily life.
- Manage life, but have taken some actions due to the perception of fields or symptoms.
- Show some impairment of well-being.
- Are frequently ill, have to see a doctor more often than common, or have to change work.
- Have had to change life conditions entirely.

Most of the countries replied the middle alternatives ("several" or "few") for all the five alternatives of severity of the problem. The Swedish COMs generally replied "most" on the mild problem alternatives and "few" on the severe problem alternatives. The Norwegian COMs did report "few" for the mild problems, and "none" as to the severe problems. In all, the participating organisations did reply very differently to these questions, differences were found not only between countries but also within countries and between the COMs and between the SAGs.

Correspondence between "electromagnetic hypersensitivity" and other syndromes

The participating organisations were asked whether "in your experience, do individuals who suffer from "electromagnetic hypersensitivity" also report problems with Multiple Chemical Sensitivity. Allergic reactions or Problems with dental alloys?" They were asked to reply with "most do", "some do", "a few do" and "no one does" as appropriate for the three syndromes.

Overall, most of the COMs who did report some correlations at all did suggest such a correlation between "electromagnetic hypersensitivity" and also reporting dental alloy problems. Allergic reactions were suggested only by one COM in Germany and one in Denmark. The COMs of Austria, Finland, France and United Kingdom did not suggest any correlations at all (by using the response "no one does"). The COMs from Faroe Island, Iceland and The Netherlands did not reply to these questions.

Most SAGs indicated very strongly that "electromagnetic hypersensitivity" individuals also reported all three other types of problems - with little variations between countries.

Appendix 2. Questionnaires to centers for occupational medicine and self aid groups

The English version of the questionnaires to the centres of occupational medicine (COMs) and self aid groups (SAGs) are shown:

- Possible health implications of subjective symptoms and electromagnetic fields. Questionnaires to centers for occupational medicine, page 2-8
- Possible health implications of subjective symptoms and electromagnetic fields. Questionnaires to self aid groups, page 9-15

Questionnaires were also written in French, German, Italian and Swedish (not included here).

Date
96-xx-xx
Your letter date

Our reference
EU/Q-EngOM
Your reference

Arbetslivsinstitutet

Attending to this matter
C Wadman

Possible health implications of subjective symptoms and electromagnetic fields

Questionnaires to centers for occupational medicine

Dear colleague

The European Commission is funding a project named "Possible health implications of subjective symptoms and electromagnetic fields". The aim of this project is to accumulate scientific knowledge and practical experiences regarding individuals who experience symptoms or other health problems related to the use of electrical appliances or proximity to sources of electric or magnetic fields. This phenomena is commonly known as "electrosensitivity" or "hypersensitivity to electricity".

We represent a group of ten scientists in six different European countries (Austria, France, Germany, Ireland, Italy and Sweden) who have been given this task. Our aim is to complete a report on this within one year of the project start (which was May 1996).

In order to obtain an overview of the social prevalence of this problem in different countries, we are sending out this questionnaire to the heads of self aid groups formed around this problem, and also to various occupational health centers or departments. With "social prevalence" we do mean the number of individuals who report health problems and who also report that these health problems are due to electric or magnetic fields - regardless of other peoples evaluation of that claim.

We ask you therefore to fill out this questionnaire and send it back as soon as possible and no later than October 15, 1996 to the following address:

Ms Cecilia Wadman
Dept of Occupational Medicine
National Institute for Working Life
S-171 84 Solna
Sweden

For your convenience, we are including an addressed envelope with stamp already included. (Alternatively, you may use fax, +46 8 82 05 56.)

We do intend to include the answers in an annex to our report. If you do not wish your answer to be included in the annex, please make a note of that on the reply form. After our report is finished and approved by the European Commission, we will send you a copy of the summary.

Sincerely yours

For the Scientific group

Cecilia Wadman

The name of your organisation (institute, clinic or department) _____

Address _____
_____
_____

Contact person _____
_____
_____

1. Concerning the involvement of your organisation with this problem

1.a Does your organisation receive questions or requests etc related to individuals ("cases") who consider themselves as "electrosensitive" - i.e. who experience symptoms or other adverse health effects which they attribute to electrical devices or to electric or magnetic fields?

0 Yes
0 No
0 I don't know

1.b Do you know of any (other) organisation that does?

0 Yes
0 No

1.c If "yes", please specify_____
_____
_____

1.d Comments _____
_____
_____
_____
_____

2. Concerning the extent of the problem

2.a How many such requests or questions have you received in the last years? Plea specify as to "nn per year".

_____

2.b What is your estimate as to the total number of such "cases" in your country?

0 Fewer than 10
0 Between 10 and 100
0 Between 100 and 1000
0 Between 1 000 and 10 000
0 More than 10 000

2.c To the best of your knowledge, do such cases occur throughout your country, o in specific areas?

0 Overall, no specific area
0 In specific area(s)

2.d If specific areas, please describe _____
_____

2.e What is your estimate as to the number of such cases in your country with sever handicap because of this?

0 Fewer than 10
0 Between 10 and 100
0 Between 100 and 1000
0 Between 1 000 and 10 000
0 More than 10 000

2.f Comments_____
_____
_____
_____
_____

3. Concerning situations where problems appear

3.a To your knowledge, do most of the cases experience problems due to:

___ exposure at work-places
___ exposure at home
___ exposure outdoors or other non-work situations

(Please mark the most common description with "1", the next with "2" and the least common with "3".)

3.b To your knowledge, for most of the cases, did the problems start at:

___ work-places
___ at home
___ outdoors or other non-work situations

(Please mark the most common description with "1", the next with "2" and the least common with "3".)

3.c In the list below, please indicate common sources of problems for the cases. Mark with "1" if very often a reported source, "2" if rather often, "3" if sometimes, "4" if rather seldom, and "5" if it is very seldom a reported cause.

___ broadcasting stations, TV towers or telecommunication masts
___ electrical appliances at home (electric clocks, hairdryers, vacuum cleaners etc)
___ electric wiring in houses
___ heavy machinery in industry
___ induction heaters and plastic welding
___ light sources (fluorescent tubes or other)
___ medical equipment such as NMR, diathermy
___ microwave ovens
___ mobile phones
___ power lines or transformer stations
___ radar stations
___ railways
___ visual display units or TV sets
___ electric welding
___ (other, please specify)_____
___ (other, please specify)_____

3.d Comments_____
_____
_____
_____

4. Concerning symptoms and related problems

4.a Please list symptoms occurring in cases which are reported in connection with the use of electrical appliances or proximity to electric or magnetic field sources. Then mark with a cross in **0** (up to) the 5 most common symptoms.

_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
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_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common
_____ **0** is common

4.b In your experience, do individuals who suffer from "electrosensitivity" also report problems with:

Multiple chemical sensitivity? _____
Allergic reactions? _____
Problems with dental alloys (amalgam)? _____

(Please indicate "most do", "some do", "a few do", "no one does" as appropriate.)

4.c Comments_____
_____
_____

5. Concerning consequences for the individuals

5.a Please indicate - based on your knowledge - the percentage of each category below that:

Perceive fields or minor symptoms but
do not suffer any consequence in daily life _____%
Manage life, but have taken some actions
due to the perception of fields or symptoms _____%
Show some impairment of well-being _____%
Are frequently ill, have to see a doctor more
often than common, or have to change work _____%
Have had to change life conditions entirely _____%

(If you can not give a percentage figure, please give one of the following descriptive terms; "most", "several", "few" or "none".)

5.b Comments_____

Thank you for your help

Date
97-10-02
Your letter date

Our reference
EU/Q-EngSelf
Your reference

Arbetslivsinstitutet

Attending to this matter
C Wadman

Possible health implications of subjective symptoms and electromagnetic field

Questionnaires to self aid groups

Dear ladies and gentlemen

The European Commission is funding a project named "Possible health implicatio of subjective symptoms and electromagnetic fields". The aim of this project is accumulate scientific knowledge and practical experiences regarding individuals w experience symptoms or other health problems related to the use of electri appliances or proximity to sources of electric or magnetic fields. This phenomena commonly known as "electrosensitivity" or "hypersensitivity to electricity".

We represent a group of ten scientists in six different European countries (Austr France, Germany, Ireland, Italy and Sweden) who have been given this task. Our a is to complete a report on this within one year of the project start (which was M 1996).

In order to obtain an overview of the social prevalence of this problem in differ countries, we are sending out this questionnaire to the heads of self aid grou formed around this problem, and also to various occupational health centers departments. With "social prevalence" we do mean the number of individuals w report health problems and who also report that these health problems are due electric or magnetic fields - regardless of other peoples evaluation of that claim.

We ask you therefore to fill out this questionnaire and send it back as soon as possible and no later than October 15, 1996 to the following address:

Ms Cecilia Wadman
Dept of Occupational Medicine
National Institute for Working Life
S-171 84 Solna
Sweden

For your convenience, we are including an addressed envelope with stamp already included. (Alternatively, you may use fax, +46 8 82 05 56.)

We do intend to include the answers in an annex to our report. If you do not wish your answer to be included in the annex, please make a note of that on the reply form. After our report is finished and approved by the European Commission, we will send you a copy of the summary.

Sincerely yours

For the Scientific group

Cecilia Wadman

The name of your group _____

Address _____
_____
_____

Contact person _____
_____
_____

Please, send us only one response for each self aid group

1. Concerning self aid group(s)

1.a Is your group the only one dealing with "electrosensitivity" in your conutry?

0 Yes
0 No
0 I don´t know

1.b If "No", how many other groups do you know about? _____

1.c How many members does your group have? _____

1.d Comments _____
_____
_____
_____
_____

2. Concerning the extent of the problem

2.a How many members of your group do experience symptoms or other health problems which are related to the use of electrical appliances or proximity to sources of electric or magnetic field?

_____

2.b What is your estimate as to the total number of such "cases" in your country?

0 Fewer than 10
0 Between 10 and 100
0 Between 100 and 1000
0 Between 1 000 and 10 000
0 More than 10 000

2.c To the best of your knowledge, do such cases occur throughout your country, or in specific areas?

0 Overall, no specific area
0 In specific area(s)

2.d If specific areas, please describe _____
_____

2.e What is your estimate as to the number of such cases in your country with severe handicap because of this?

0 Fewer than 10
0 Between 10 and 100
0 Between 100 and 1000
0 Between 1 000 and 10 000
0 More than 10 000

2.f Comments_____
_____
_____
_____
_____

3. Concerning situations where problems appear

3.a To your knowledge, do most of the cases experience problems due to:

___ exposure at work-places
___ exposure at home
___ exposure outdoors or other non-work situations

(Please mark the most common description with "1", the next with "2" and the le common with "3".)

3.b To your knowledge, for most of the cases, did the problems start at:

___ work-places
___ at home
___ outdoors or other non-work situations

(Please mark the most common description with "1", the next with "2" and the le common with "3".)

3.c In the list below, please indicate common sources of problems for the cases. Ma with "1" if very often a reported source, "2" if rather often, "3" if sometimes, "4" rather seldom, and "5" if it is very seldom a reported cause.

____ broadcasting stations, TV towers or telecommunication masts
____ electrical appliances at home (electric clocks, hairdryers, vacuum cleaners etc)
____ electric wiring in houses
____ heavy machinery in industry
____ induction heaters and plastic welding
____ light sources (fluorescent tubes or other)
____ medical equipment such as NMR, diathermy
____ microwave ovens
____ mobile phones
____ power lines or transformer stations
____ radar stations
____ railways
____ visual display units or TV sets
____ electric welding
____ (other, please specify)_____
____ (other, please specify)_____

3.d Comments_____
_____
_____
_____

4. Concerning symptoms and related problems

4.a Please list symptoms occurring in cases in your group which are reported in connection with the use of electrical appliances or proximity to electric or magnetic field sources. Then mark with a cross in **0** (up to) the 5 most common symptoms.

_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common
_____	**0** is common

4.b In your experience, do individuals who suffer from "electrosensitivity" also report problems with:

Multiple chemical sensitivity? _____
Allergic reactions? _____
Problems with dental alloys (amalgam)? _____

(Please indicate "most do", "some do", "a few do", "no one does" as appropriate.)

4.c Comments_____
_____
_____

5. Concerning consequences for the individuals

5.a Please indicate - based on your perception as to members of your group - the percentage of each category below that:

Perceive fields or minor symptoms but
do not suffer any consequence in daily life _____%
Manage life, but have taken some actions
due to the perception of fields or symptoms _____%
Show some impairment of well-being _____%
Are frequently ill, have to see a doctor more
often than common, or have to change work _____%
Have had to change life conditions entirely _____%

(If you can not give a percentage figure, please give one of the following descriptive terms; "most", "several", "few" or "none".)

5.b Comments_____
_____
_____
_____
_____
_____
_____
_____
_____

Thank you for your help

Appendix 3. Review of investigations into possible causal factors for subjective symptoms related to "electromagnetic hypersensitivity"

Preamble

As described in the introduction, "electromagnetic hypersensitivity" is a phenomenon where individuals experience adverse effects while using or being in the vicinity of electric, magnetic or electromagnetic devices. Often, these attributions are specifically directed to electric and/or magnetic fields emanating from these appliances, even if other factors - both physical and others - have also been suggested. This attribution to specific factors must not be confused with a statement of an established causality.

In our view, this important caveat is based on both the inability, in single (individual) observations ("case reports"), to identify one out of a number of factors present in a situation as being "responsible" for the reaction, and the difficulty to separate out a direct causal link from that of a psychosomatically mediated link without additional information. This latter difficulty is augmented by the current lack of knowledge concerning a mechanism for interaction between weak electric or magnetic fields and biological systems.

In the text below, we therefore wish to describe the results of such scientific investigations that try to establish or indicate whether there is a link between certain factors (especially exposure to various electric or magnetic fields) and symptoms typical of those claiming to be "electromagnetic hypersensitive".

As discussed elsewhere in this report, there are a number of indications that the designation "electromagnetic hypersensitivity" does not stand for a homogenous group which is distinct from other individuals. This is especially evident when indications from different European countries are compared (see the chapter on description of "electromagnetic hypersensitivity". Furthermore, even within one country, such as Sweden, indications for heterogeneity of "electromagnetic hypersensitivity" have appeared (14, 51, 111), see further below. Thus, the self-indication by an individual that he or she is "electromagnetic hypersensitive" does not appear to be an optimal definition on which to base deliberations, since a/ it could be a conglomerate of different etiologies, and b/ it may also miss other individuals who share the same etiology for certain symptoms with (some) "electromagnetic hypersensitive" individuals, but who may not be aware of - or have rejected - the "electromagnetic hypersensitivity" label. As will become clear

in the following discussion, a problem is that there are - at present - often no good alternatives to the self-definition of electromagnetic hypersensitivity".

Nevertheless, it was found prudent to separate the discussion of the etiology of the relevant symptoms associated with "electromagnetic hypersensitivity" - and the possible role of electromagnetic phenomena in this etiology - into two parts:

- First, the scientific literature was reviewed for studies relating the relevant symptoms to electric or magnetic fields in the general population. Relevant situations were - as outlined above - neurasthenic or similar symptoms appearing in situations with both low and higher frequencies of electric or magnetic fields. Another situation is that of skin-related symptoms in office workplaces (where use of visual display units, VDUs, occur). This approach was taken in order to cover the possibility that the symptom(s) may be generally related to fields - i.e. in the general or the general working populations, regardless of any specific "sensitivity".
- Secondly, the possibility of a specific "sensitivity" was examined, by way of reviewing efforts to identify groups of such individuals, either by specific reference to an exposure, or by other means such as hormone analyses, personality profiles etc. Attempts to discern factors of importance to symptom development within such groups or in relation to such "sensitivity" are also reviewed.

Scientific investigations appearing in peer reviewed papers, technical reports, conference proceedings etc. were scrutinized for relevant information. Some papers were excluded from the review, for a variety of reasons: the information was not considered to be relevant to the issue of "electromagnetic hypersensitivity or related symptoms"; there was a dearth of information on methods which could not be rectified by contacts with the researcher(s); the study was not based on well formulated hypotheses; and - generally - a low quality of the study or the report.

Throughout this text, it should be observed that a statement such as "an association between....." should not be inferred to suggest that a causal link has been established. A verification of a causal link between e.g. an external factor such as a field exposure and an effect is normally considered to require additional data than only a statistical association (see e.g. Hill (46) or Rothman (87) for a general discussion). Basically, such additional data are largely absent in terms of the reviewed associations under scrutiny. Furthermore, the terms "indicated" or "suggested" do - in this text - primarily refer to the presence (or absence) of a statistical association, not to a causal link.

General population-based studies

Aim

This part of the section has the following purposes:

- To determine, in studies based on general populations or general working populations, whether relationships exist between exposure to electric or magnetic fields in different frequencies and neurasthenic symptoms.
- To determine, in studies based on general working populations in offices where visual display units are used, whether relationships exist between exposure to electric or magnetic fields as they occur in these situations and skin disorders or symptoms.

The review is not concerned with the possibility that exposure to electric or magnetic fields is related to the development of diseases such as cancer or Alzheimer´s disease, as these are not characteristics of "electromagnetic hypersensitivity". It should be recognized, however, that an individual´s worry and concern about adverse health effects - including such diseases - may be of relevance to "electromagnetic hypersensitivity" (see further below).

The term "general" implies (here) that no attempt was made in the design of these studies to *a priori* restrict the study population - or the case group - to individuals with any special sensitivity. Thus, studies performed on groups of individuals specifically selected because of their claim for "electrosenitivity" are excluded here. Likewise, studies based on selected individuals with some (other) defined individual traits of possible relevance to "electrosenitivity" are also excluded. They are treated in a separate part of the text below.

In principle, the review will look at both observational (epidemiological) and experimental studies on humans. It is recognized that a large array of studies have examined animal experimental studies. Where appropriate, brief references to such studies are mentioned, but in general, the readers are referred elsewhere for such information. The motivation for this - beyond the practical fact that this would have extended the review considerably - is that a "human" interpretation of animal data appear problematic, taking into account both the nature of the effects, and the possibility of psychosomatic mechanisms.

Neurasthenic symptoms and exposure to low frequency fields

Epidemiological studies on headaches

Relationships between the occurrence of headaches with proximity to overhead power lines have been investigated in a few epidemiological (observational) studies. Dowson and colleagues (29) observed a significantly higher occurrence

of headaches and migraines among resident living at a moderate distance from the power lines (60-80 m) than among those living closer to or among those living further away from the lines. This study had the advantage of using a validated headaches questionnaire, but suffered from a low response rate (60%) and limited analysis of confounding. Furthermore, the absence of a "dose-response" (if "dose" is implied by distance to the power line) further detracts from the credibility of the association.

In another residential study (82), the study population was chosen among residents in towns adjacent to a powerline, individuals residing close to the powerline as well as petitioners concerned with the powerline. 545 of these were randomly selected and were asked about depressive symptoms, headaches, attitudes and demographic variables - with a 70% response rate. No consistent association between proximity to powerlines and headaches (migrain or non-migraine) were found. In still another paper (70), the investigators failed to indicate differences in migraine or non-migraine headaches in relation to the proximity of a powerline.

In a prospective study (41, hitherto only reported in a conference abstract) on power line workers, no association between the 6 year incidence of headaches and measured levels of magnetic or electric fields were found. Likewise, Broadbent et al. and Gamberale and coworkers (cited by Paneth (78)), failed to find associations between headache and measured field level.

Overall, the amount of support for an association between proximity to power lines and/or field levels and headaches or migraine is very limited, even if the limited number of studies together with the limited methodology in some of the studies precludes any definite conclusion.

Epidemiological studies on depressive, neurasthenic or similar symptoms

It should be observed that the following studies have used varying endpoint defintions such as depressive symptoms, depression, neurasthenic symptoms etc, which makes an overall comparison more difficult.

In the study by Poole and coworkers (82) already referred to, depressive symptoms were ascertained by a validated telephone interview schedule. Subjects were classified as living "near" or not to a transmission line. An association was noted between proximity to power lines and depressive symptoms, with an odds ratio of 2.8 (1.6-5.1). Although concerns about the transmission line were also associated with depressive symptoms, confounder analysis (adjustments) for this and other variables did not reduce the relationship between depressive symptoms and power line proximity. The study by Dowson et al. (29) also found an association between depression and power line proximity. Likewise, Perry and colleagues reported slightly increased magnetic field levels at the door of houses with cases of depressive symptoms than at houses where non-cases lived (0.23 vs 0.21 μT) (Perry et al. 1989, cf Savitz, Boyle et al. (95)). Few details were given in these latter reports, though, and it should be noted that both studies failed to provide any substantial report on the impact of possible confounding factors.

In contrast, McMahon et al. (69) failed to find such an association - the odds ratio was 0.9 (0.5-1.8), comparing those residing on the power line easement with those one block away. While the reported analysis was based on the proximity measure, measurements at the front of the house of 60 Hz magnetic fields verified a difference between the easement (average 0.49 μT) and one block away (0.07 μT). It should be noted that this study has been criticized for its choice of study population - a well-to-do area - which presumably could have caused too limited contrast within the study population (27). As we see it, however, this objection would be dependent on the (assumed) presence of other necessary factors for the causation of depression - a small contrast (apart from the factor under study) would otherwise be optimal for the study. See further Paneth (78) for a general discussion on the requirements for epidemiological studies within this field.

In a second paper from the same study (70), they also failed to indicate an association between proximity to power lines (or measured magnetic fields) and poor appetite, sleep and concentration problems. Taking these endpoint together (and also including headaches - cf above), the odds ratio between them and proximity to power lines (living on vs off the easement) was 0.85 (0.45-1.62). In some contrast to this, the association between "worry about the powerline" and the health effects was 2.24 (1.15-4.37).

Savitz and coworkers (95) examined the prevalence of depression among electrical workers. Overall, no real tendency of increased risk for "electrical" vs "non-electrical" workers was found. Among electricians, however, increased odds ratios were noted, especially for "trouble concentrating", where an odds ratio of 2.2 (1.0-5.2) was found when comparing electricians with non-electrical workers. The authors caution against drawing too strong conclusions from the findings, due to a/ the absence of exposure information beyound job title (they note that electricians "are not the group most certain to have elevated EMF exposure" (related to the general problem of using job titles as surrogates for exposure), b/ that other occupational factors (e.g. solvent exposure) were not adjusted for, and should be considered "as an alternative explanation for the associations seen for electricians", and c/ the limited statistical power in the analysis of subgroups of electrical workers.

Another recent study by Chevalier et al. (26) investigated in a nested case-control study at the EDF-GDF (French National Electricity and Gas) company the association between various factors - both occupational and non-occupational - and diagnoses of anxiety or depression. The principal findings of the multivariate analysis revealed an array of statistically significant factors ($p<0.1$):

- For depression: being a woman, being a supervisor, job changes, parental problems, difficulties with children, divorced or separated and having had a serious accident or illness.
- For anxiety: being a woman, being a supervisor, having a job not self-chosen, recent job transfer, job changes, parental problems and being divorced or separated.

In the multivariate analysis, there were no significant influences of performing VDU work or being exposed to "electrical risks".

A study of clinical symptoms in two clusters of individuals living near powerlines in France showed that neurasthenic symptoms appeared in relation to exposure awareness leading to anxiety. Taking into account confounding factors, no consistent association between symptoms and living in the proximity to powerline was found (Luis Miro, personal communication).

Some earlier studies on occupational groups by Knave et al. , Broadbent et al. , Baroncelli et al. and Gamberale et al. (as reported by Paneth (78)) all failed to find associations between measured or estimated levels of electric or magnetic fields and various depressive or anxiety symptoms. In a recent study on workers in the power industry ((41), so far reported only in a conference abstract), the incidences of depression, sleep disturbances, tiredness, tinglings and neuropathy, dizzines or stomach related stress symptoms were not found to be associated with electric nor with magnetic field levels. The 9 year incidence of neurasthenic symptoms (irritation, anxiety, generally worried, fatigued without cause, restlessnes and lack of concentrations) was, however, associated with exposure to magnetic field exposures - even if the final analysis was unable to entirely rule out a confounding effect of solvent exposure and/or workplace worry.

In some contrast to the findings on headaches, there are here some more credible indications of associations between these types of symptoms and field levels or proxies for field level exposures around power lines (but not from occupational settings). On balance, however, there are still too few studies, too limited methodology in some of the studies, and too varied results for any definite conclusions to be made concerning depressive or neurasthenic symptoms (as defined by the various authors).

Epidemiological studies on suicide

Recently, Baris and coworkers reported some indications of an excess risk of suicide being related to exposure among blue collar electrical workers (5). This was further examined in a case-control study (6), where adjustments for some other factors (alcohol consumption, socioeconomic scale, marital status and mental disorders) were also performed. Workers exposed to median levels of accumulated electric field exposures had a risk ratio of 2.8 (0.9-8.1) compared to those with lower exposure. Among highly exposed workers, the risk ratio was lower (1.8; 0.4-8.5). No excess risks were found in association with magnetic fields or pulsed electromagnetic fields, nor with current exposure to any fields. Long term exposure was the parameter primarily indicated by the authors, but results were similar when based on current exposure (for the year in which suicide occurred). The authors caution against drawing any causal conclusions from this study, because of various possible sources of bias within the study (incomplete case ascertainment, exposure misclassification, lack of adjustments for all relevant confounders, and limited sample size). In addition, the lack of a dose-response relationship should be noted.

Earlier studies on suicide in association with field levels, electrical occupations or proximity to power lines have given mixed results. The limited methodology in these other studies should be kept in mind, though. In two different publications. 598 suicide cases were found to have higher estimated (84) or measured (79) electric or magnetic field levels. In contrast, neither Baris and Armstrong (4) nor McDowell (67) found any relationships between suicide and electrical job titles or vicinity to power lines, respectively.

Again, studies are too few, too often with limitations in their methodology and have too varied results - even within the recent and more adequately designed positive study by Baris et al. - for any affirmative conclusions about suicide in relation to electric or magnetic fields to be made.

Experimental studies on melatonin secretion and EMF

In a recent review, Lambrozo and coworkers (60) summarized the current knowledge concerning animal or human experiments with melatonin and EMF exposure regimens:

- Electric 50/60 Hz fields have been shown to reduce pineal melatonin synthesis or increase the melatonin degradation in four studies on rodents, but failure to find such effects have also been reported in one study. Levels varied between 2 and 65 kV/m.
- For magnetic field experiments with rodents, a number of studies have also indicated a decrease in night time melatonin in rodents, after various exposure regimens using levels from 0.02 to 100 μT. In a few studies, a lack of such responses was reported. In both the electric and magnetic field studies, lack of dose-response relationships (with dose = exposure level) were noted in some of the positive studies.
- Data on non-rodent mammals are very scarce, and - in the two studies performed - essentially non-positive.
- Human data are, again, very limited. Two groups have investigated this possibility, with mixed results (see however further below).

In addition and subsequent to this review, Graham and coworkers (39, 40) and Selmaoui et al. (96) reported failures to find overall changes in nocturnal melatonin related to night time magnetic field exposures among both women and men. (Part of the first of these studies was previously reported, but then as partly positive. This was included in the review by Lambrozo above.) These studies all examined nightime exposure and its possible effect on nightime melatonin changes. David and coworkers (unpublished, presented to the group in München, November 1996) investigated also the effect of daytime exposure during day - and could find no effect of magnetic field exposure on melatonin regardless of the time of the day.

Another study investigated effects on circadian rhythm of electric field exposure among human volunteer isolated from any cues as to the diurnal light variations. Small (up to 5%) variations in the circadian rhythm were noted in this

isolated situation (Sulzman et al., cited by Paneth (78)). The clinical or health implication of this finding is however unclear.

Other experimental studies on neurological and related functions and low frequency fields

A number of other endpoints such as EEG, ECG and reaction times have been studied in the laboratory, both with animal and human subjects. Experiments on humans are briefly reviewed here - the briefness is motivated by the difficulty in interpreting the findings in terms of adverse health outcomes. For a review of animal experimental studies, we refer to other reviews.

Bell and coworkers (7) exposed patients and volunteers to 7.8 μT static and 60 Hz magnetic fields, and recorded increased EEG (electroencephalogram) activity in the frequency range 1-18.5 Hz. The static and 60 Hz fields appeared to act independently. Similar results were noted by Lyskov et al. (65). who found an increased α (7.6-13.9 Hz) and β (14.2-20 Hz) but decreased δ (1.5-3.9 Hz) activity after exposure to continuous or intermittent 45 Hz, 1260 μT magnetic fields. Cook and coworkers (28) found changes in auditory (but not visually) evoked potential after 9 kV/m and 20 μT 60 Hz electric and magnetic field exposures. In a series of experiments by Ruppe and coworkers (88), volunteers were exposed to strong 50 Hz magnetic field levels of up to 2 mT for 10 minute durations. No effects on EEG readings were noted.

In three studies, effects on electrocardiograms and pulse rates were investigated. In the study by Cook et al. (28) already referred to, a decrease in heart rates was noted. An interaction with the order of expoure/sham sessions was also observed; the heart rate decrease was only found if the first and the last session was "exposed", not when exposure occurred in the intermediate sessions. Closer scrutiny also revealed that the difference in heart rate was due to changes primarily in the sham sessions; in the morning, a decrease in the heart rate over the three hours was noted in both exposed and sham situations, while in the afternoon, this pattern was again observed for the exposed, but not for the sham subjects. In our opinion, these results lead themelves to various interpretations - and it is not clear whether there is in fact only an order effect or an order + exposure effect, or - if an exposure effect exist - if it should be considered harmful or beneficial.

Using somewhat lower exposure levels (3-4 kV/m and 1-7 μT), Korpinen and Partanen (56) failed to note any changes in the pulse rate due to exposure. Some autonomic function tests being related to the cardiovasvular system (orthostatic tests, Valsalva maneuver and deep breathing) were also evaluated by the same authors (57), again without observing an effect related to EMF. However, some weakness in the protocol and execution of the study were identified. In the experiments by Ruppe and coworkers (88) (see above), no effects on ECG, pulse rates or changes in body temperatures were noted.

Reduced number of errors but similar reaction times in tests performed during exposure vs sham were noted in the study by Cook and coworkers (28). In

contrast, neither Lyskov et al. (65) nor Podd and coworkers (81) reported effects of strong magnetic fields (1260 μT, 1100 μT) on reaction times. It should be noted, however, that Podd et al. used quasi-static frequencies (0.1-0.2 Hz) and very short exposure durations. Cook et al. (28) also summarized earlier studies on reaction time, they describe the results as "inconsistent". After strong but short exposure regiments (2 mT, 10 minutes), some psychological tests indicated a reduction of mental performance (88), although the statistical significance of the results were unclear.

Summary - low frequency fields

Overall, the hypothesis of increased risks of various neurasthenic symptoms being related to environmental or occupational exposure to low frequency electric or magnetic fields is - at present - not supported by strong or consistent epidemiological findings. This lack of overall support is partly due to the inconsistency of the findings, the limited methodology in some of the studies and also to the limited number of studies performed. The best case - primarily in terms of need of future research - appear to be made by environmental exposure to fields from power lines and depressive disorders. For this situation, however, it is - based on available data - difficult to separate (presumed) effects due to the physical presence of the fields from those dependent on psychosomatic mechanisms.

The use of such surrogates for EMF exposure as proximity to power lines etc. has been critizised, as several unidentified confounders (such as traffic density, urban location of houses etc.) may interfere with the interpretation of the results (Valberg 1996). In some of the more recent studies, measurements of EMF exposures have been conducted. It can be observed, however, that the inclusion of data based on measurements have generally not resulted in stronger associations with the effects. This lack of further substantiation of the association when better exposure assessments are made, can be interpreted in several ways, though, among them;

- a lack of a "true" relationships with the fields, where some other factor(s) ("confounders") may be responsible for the association seen.
- the choice of an inappropriate exposure parameter or field desriptor - which again points to the absence of information on a possible causal mechanism

Considerable attention has been given the possibility that psychosomatic mechanisms may be involved here. Some supporting data from the reviewed studies were found by Poole et al. (82), by McMahan (70) and the cluster investigation reported by Miro, as already described and briefly discussed above. It should be noted, however, that - again - a causal link between EMF worry and e.g. depressive symptoms can not be considered as established, it remains a possibility in these cross-sectional studies that the effect may have caused increased concern and worry. As a general remark, the current inability to formulate a relevant mechanism or pathway for a "direct" effect tends to favour the credibility of a psychosomatic mechanism. It may be counter-argued,

however, that the results of the study by Poole et al. (82), where adjustments were made for attitudes and anxiety, would speak against the psychosomatic mechanism. Better knowledge about socioeconomic variations close to and further away from powerlines as well as further investigations into the impact of attitudes etc. appear warranted.

The most consistent human experimental results appear to come from investigations of EEG activity changes caused by EMF's. While these indications do motivate further investigations, a few points are worth mentioning; a/ the exposure levels were high (8 - 1260 μT), b/ the interpretation of these changes appear unclear - in our opinion, they indicate a biological effect, but not necessarily an adverse effect and c/ effects have not been consistently found by all investigators. This latter point is augmented by the observation that while effects on brain potentials were noted in a few studies, they did apparently not result in reduced reaction times - as measured in two of them. Few other reliable effects were noted in the reviewed experimental studies on humans. The key issue of whether melatonin secretion or circadian rhythms are influenced by EMF's can not be answered by current data, studies on rodent give some support for the idea, but data from non-rodent or from human subjects have hirtherto failed to do so.

For both observational and experimental studies on possible effects of low frequency, low level electric or magnetic fields, this area suffers from the general inability to describe possible mechanisms or biological pathways linking an exposure parameter to the investigated effect(s), and the concommitant uncertainity as to the correct exposure index (average, peak, short or long term exposure, electric or magnetic field component etc.). Several hypothetical biological pathways have been proposed, but none have been firmly established. As discussed by e.g. Paneth (78), Savitz et al. (95), Sobel and coworkers (100) and others, two primary contenders for such a role of interest to these outcomes are calcium efflux across the cell membrane, and changes in melatonin secretion. As further argued by Paneth (78), the latter hypothesized pathway (decreased secretion of melatonin caused by electric or magnetic field exposure) would have the advantage of a/ being more selective toward the types of effects reported here, and b/ being directly testable on whole animal or human subjects. (It should be noted that such a pathway (EMF -> melatonin secretion changes -> disorders), does not describe a "mechanism" in the sense that the "dose" can be identified. In our opinion, the term "mechanism" should refer to knowledge about the physical interaction process. Nevertheless, a firm indication of such a pathway may enhance the design of further studies where a relevant definition of "dose" could be achieved.)

In conclusion, while results exist that clearly motivate further research into the possibility of adverse neurasthenic or neurological reactions to low frequency fields, current knowledge is unable to strongly support this possibility. This is in part due to the inconsistent and partly contradictory result obtained, and in part due to the current inability to determine the relevant exposure parameters (if any).

Neurasthenic symptoms and exposure to radiofrequency fields

In a limited number of studies, neurasthenic or similar symptoms were investigated in relation to radiofrequency field exposures. Both observational (epidemiological) studies in occupational and general public/residential settings have been performed, as well as some experimental studies on humans. (For a review of experimental studies on animals, see WHO (118), or McKinlay, Andersen et al. (68).

Occupational studies

In the 1960-ies and 70-ies, various neurasthenic symptoms and symptoms of functional disturbances of the nervous and the cardiovascular systems were reported in Soviet and Eastern European literature among military personnel and other workers chronically exposed to RF. In some studies, ECG or EEG abnormalities were also observed (38, 106, 117, 118). Based on this, the term "microwave sickness" or "neurotic syndrome" was coined. The exposures were rarely estimated - with exception of one study (99), where exposure levels were given from dozens to hundreds of V/m. These studies are, however, not easily evaluated because of several drawbacks (vague description of cases, lack of adequate control groups, poor statistical analyses etc., 118). Some other earlier epidemiological studies reported failure in finding - in exposed groups or groups assumed to be exposed - any significant excess of "neurotic syndrome" (97), ECG (97), hospital admission rates due to mental, psychoneurotic or personality disorders (86) and clinical neurological or psychometric findings (73). For further review, see Bergqvist (17).

Among plastic welders with high documented exposures to RF, increased occurrences of paresthesia (numbness) of the hands were found (22, 54). Both studies were small, and adjustments for possible confounders were generally not performed, nevertheless the results should be regarded with some interest, as these two studies are at least partly based on actual measurements, and these clearly indicated excessive exposure levels - well above those recommended e.g. by IRPA (30). In one of these studies (54), a non-significant excess of neurasthenic symptoms was found, whereas headaches or tiredness were not reported more often by the exposed. The other study by Bini et al. (22) found no significant associations between central nervous system findings and exposure (no details given, though).

An excess of self-reported heart problems was in another study found among male physiotherapists using RF (shortwave or microwave) diathermy equipment (42). Self-reports of both disease and exposure (use vs non-use) as well as a low participation rate (58%) do detract from the credibility of the association, though.

In an unpublished study (Luis Miro, personal communication), 105 exposed microwave workers and 62 controls were been examined. The exposure was reported as chronic occupational exposure (exposed all day to about 0.1 W/m^2). No clinical problems nor subjective complaints were noted among the controls. In contrast, some 63% of the exposed workers had some complaint, which was

identified as neurasthenic syndrome (headache, fatigue, heart palpation, vertigo, thermoregulatory disorder, nausea and behaviour modifications) in 30%. In 8.6%, this condition was serious enough to justify treatment. Furthermore, after investigating hematological functions, most (87%) of the exposed but only 3% of the unexposed presented a significant increase in osmotic globular resistance.

Residential exposure to RF fields

Various adverse health outcomes were investigated - in response to resident's petitions - in the vicinity of a shortwave transmitter based in Schwarzenburg near Berne, Switzerland (1). The broadcast consists of active periods with shorter (15 min) inactive periods for direction changes. Three zones (A, B and C) were defined around the transmitter at increasing distances, C being several km away. Exposure to RF signals (6-22 MHz) was measured, and indicated increasing levels in the C - B - A series. At C, levels were similar to background level (0.08 mA/m), while at A, the median level during broadcast was 1.6 mA/m (but still considerably lower than the IRPA guidelines of 73 mA/m). 100-150 individuals from each zone took part in at least one of the several investigations. Socioeconomic status or attitudes varied across the zones, and were accordingly adjusted for in the analysis.

Difficulty in sleeping was more prevalent closer to the transmitter, and did exhibit a relationship with measured field levels: Increasing field levels from 1 to 10 mA/m was related to an odds ratio of 3.2 (1.8-5.5). Weakness, nervosity etc were apparently secondary to this difficulty in maintaining sleep. Experiments were performed, with changes in the transmitter (shut down or directional changes); individual's diary notation of sleeping difficulty correlated with these changes. However, attempts to indicate a melatonin mechanism for this relationship failed. The authors were - in their own conclusions - not able to fully differentiate between a direct biophysical relationship, a stress-mediated one or a psychosomatic relationship.

These results do - in our opinion - merit further study. There are some aspects of the study, that makes it difficult to evaluate the outcome, though:

- This study was based on a petition - presumably because of an existing problem. Thus, it can be seen as a cluster investigation. This comment is primarily relevant for the cross-sectional part of the study, where it will decrease the generalizability of the results. The experimental part is presumably less affected, unless the selection process (choosing this particular site) have resulted in a particularly sensitive population being studied. Then, while conclusions about the experimental observations *per se* may still be valid, inference as to the commonality of such reactions should perhaps not be made.
- Some design aspects are not clear, such as the impact of a rather limited response rate, some details of the analysis, and the full confirmation of experimental blindness.
- The use of melatonin levels as a possible intermediate in the pathway between RF exposure and sleep problem appear - to us - not well based in the literature. It should preferably have been used as a possible confounder - but then that would have made it necessary to evaluate all participants for melatonin levels.

Notwithstanding these limitations, further investigations into this possibility appear warranted. Currently, it is - in our opinion - not posible to draw any general conclusions from this single study.

The US Embassy in Moscow was intermittently irradiated between 1963 and 1975 by an RF source of a few GHz, resulting in exposure levels of some 0.05-0.2 W/m^2. An extensive survey of adverse health problems among the Embassy personnel and dependents living at the Embassy. Although various health outcomes among individuals were detected, including some with neurasthenic symptoms, no health outcomes was, in the final analysis, judged to be linked to the exposure (64).

Mobile phone users

In some countries, anecdotal reports have appeared that describe various symptoms such as headaches, feeling of warmth etc in some individuals when using mobile phones. Results of studies on this phenomenon have - so far - been very limited (47), but some research activities on this are currently ongoing. Another general concern being expressed is that of exposure due to mobile tele-communication base stations. To our knowledge, studies related to these latter situations have not been performed.

It should be noted that while public exposure to base stations appear negligible, thermal exposure from hand-held mobile phones ("cellular phones") could in some extreme circumstances be of the same order as - or possibly also exceed - current basic limits or safety standards. Major difficulties exist, however, in the ascertainment of the exposure in these situations, because of uncertainties in measuring and/or calculating the relevant dosimetric quantity . See further Kuster and Balzano (58).

Other observations in humans

Cutaneous perception (primarily as heat or pain) is possible at high exposure levels to frequencies in the order of a few GHz; auditory effects ("microwave hearing"), and effects of contact or induced currents, exceeding stimulating thresholds of excitable tissues, have been experimentally observed (118). Some of these effects can be considered "physiological" rather than "adverse", and furthermore, they appear as a consequence of short term exposure to RF levels much higher than commonly occurring occupational or environmental levels. Ten cases of complaints allegedly associated with RF field exposures have been collected in a French data base, but without possibility to establish a link with RF exposure (Miro, personal communication).

An overexposure to high levels of RF of a few GHz frequency can apparently induce neurasthenic symptoms and also EEG abnormalities (106, 118). Headache, fatigue, heart palpations anxiety, memory loss, insomnia, hyperhydrosis and other subjective symptoms were reported, mainly in subjects overexposed during

maintenance of radar or military systems; in a few subjects EEG abnormalities were also found (106). Even if in some cases the exposure was not estimated, it can be concluded that in most instances, such effects have been reported from exposure situations where the levels are a few to several orders of magnitude higher than current guidelines (e.g. by ICNIRP), and are considered to be due to thermal interactions of RF fields with the body (118). As a consequence, these observations can not be applied to chronic low level RF exposure, which is under scrutiny here.

In two recent experimental studies, some effects on EEG pattern and on sleep parameters (shortened sleep latency, decreased REM sleep) (66) and on the EEG alpha activity (110) have been reported after exposure to pulsed fields from mobile phones or similar sources. The exposure ranged from 0.5 W/m^2 (900 MHz pulse-modulated at 217 Hz (66)) to less than 0.01 W/m^2 (150 MHz pulse-modulated at 217 Hz; (110). In another experiment, exposure to 1 W/m^2 of 2.45 Ghz continuous fields did not result in any noticeable effects on nervous system functions, where exposure to 10 W/m^2 did influence some perception test results (71).

Summary - radiofrequency fields

For high RF exposures after accidental overexposures (capable of causing substantial thermal effects), various neurological and neurasthenic effects have been described, as well as other medically well defined conditions. Numbness of the hands does also appear to be a reasonably well documented effect of moderately high RF exposures - appearing among plastic welders exposed to levels above current guidelines. No other neurological or neurasthenic effects of RF exposures at moderately high levels could be verified.

The main concern here, however, is with low-level RF exposures - i.e. below those causing thermal interactions with the body, and below the expoure limits set by various national and international guidelines or standards. Epidemiological and experimental studies that investigate the possibility of neurasthenic effects of such low level RF exposures are limited. The sleep problems reported around a Swiss shortwave transmitter motivates some further comments here, however, as the investigators made considerable efforts to exclude a psychosomatic mechanism. This report - as well as some indications from the study reported by Miro (see above) motivates further research, but the data is at present not sufficient to establish neither the reliance of the adverse effect (neurasthenic symptom or difficulty in sleeping) on mechanisms other than psychosomatic ones nor indeed its general existence. The various problems anecdotally reported by mobile phone users (headaches etc.) and the few experimental studies on nerve system functions, sleep effect etc. do also point to the need for further scientific investigations.

At the same time, the paucity of studies with good exposure assessment and sophisticated analyses does at the same time make it impossible to fully dismiss the suggestion of neurasthenic effects of low level RF exposures on the basis of these studies. The plausibility of the hypothesis is also partly reduced due to the

inability - at present - to describe and verify mechanisms that could elicit a biological response of RF exposures below those relevant for thermal interactions. In some contrast, it is possible to formulate a psychosomatic mechanism of interaction - but of course then only for situations where the individual is aware of the exposure.

As was the case for low frequency fields, the current (limited) scientific knowledge is unable to strongly support the suggestion that low level RF fields would cause neurasthenic effects. A few observations and reports are worthy of further investigations, though.

Skin symptoms among VDU users

Description of skin complaints or disorders among VDU users

The first reports of facial, throat or hand skin problems among VDU users appeared - to our knowledge - from the UK (Rycroft 1984 cf Stenberg 102), followed by some Norwegian reports (25, 72, 107). The first Swedish reports were published in the middle or late eighties (9, 63, 113), although unpublished case descriptions had appeared earlier. Since then, most published studies have been performed in Sweden, even if case reports have also appeared in other countries, e.g. USA (36, 37) and Japan (Matsunaga et al. 1988, cf Stenberg 102). It should be noted, however, that reports have also appeared that indicate a lack of "VDU-related dermatoses" or "VDU-related dermatological problems in some countries; e.g. from Italy, where 736 VDU workers seen at the Institute of Occupational Medicine in Milano, without reporting any such cases (80).

Descriptions of these cases often emphasized unspecific symptoms similar to those of various skin disorders such as rosacea (pain, itching, burning), with mild objective signs (rashes, redness, sometimes describable as a non-specific erythema) but with more pronounced or intense symptoms (16) (9). It is also noteworthy that in the cohort study by Bergqvist and Wahlberg (20), 25% were given a diagnosis of a skin disorder, while only 19% of the same cohort did report skin symptoms at the same day - but prior to visiting the dermatologist. (And, as indicated below, with only a minor overlap.) A major reason for these discrepancies probably lies in the observations that most (86%) of the diagnosed skin disorders were judged to be mild, with the remainder of moderate severity (20).

Generally, these skin symptoms appear transient, often being reduced after work or over weekends (16). In a 5 year follow-up study by Eriksson and co-workers (33), 63% of the skin problems present at the onset disappeared during the study time. The occurrence of changes in work situations or the "electrical environment" were more common among those who remained as cases than among those who recovered - the full interpretation of this is, however, unclear; both ineffective measures and measures directed to more severe (but less responsive) cases could be involved. Of 201 cases examined by Berg (9), 75% were followed up 8 months later. For 14% the problems had ceased, while 52%

reported less severe problems and 28% had similar skin complaints. For 6%, the problems had increased. Most (87%) had continued their work at the VDUs.

It must be emphasized, however, that this description of mild skin problems that often resolve without remedial actions - while common - does not apply to all individuals concerned. A smaller group describe their health problems as intense and with major social consequences, and their problems are also described as increasing if remedial actions are not taken. For example, in the study by Berg (9) on referred patients, 5 individuals (3% of the follow up) had markedly different symptoms (but few objective signs), and had declared themselves as "hypersensitive to electricity" - had quit the VDU work and described serious consequences in their daily life.

The research experience gained on such more severely afflicted individuals are discussed in a separate section below.

Comparisons of self-reported symptoms and objective signs or diagnosed skin disorders have given varied results. According to Berg (10), a fairly good correlation was noted between self-reported skin complaints amd clinical diagnoses (depending on both signs and symptoms) - about 87% of the skin complaint statuses were confirmed by the diagnoses. However, the correlation was rather poor between skin complaints and current signs (46% confirmation). In another cohort study by Bergqvist and Wahlberg (20), the correspondence between skin symptoms and diagnoses was rather poor, with only 33% of those reporting symptom were given a diagnosis. (It should be noted that the clinical criteria for rosacea was different in these two studies, Berg et al. used a much broader definition.)

From case reports, a high degree of one-sidedness of symptoms (at the side of the face turned to the VDU) have often been noted (9). When examining this in a cohort (i.e. when individuals were not self-selected), no such unilaterality was observed (13); while many had unilateral rashes, they were at least as common on the side not turned towards the VDU. A reasonable explanation for the unilaterality towards the VDU in case reports appears to be that of a selection process, individuals with mild/modest skin rashes at the "wrong" side of the face will perhaps not approach a dermatologist for "VDU-related skin problems".

Epidemiological investigation into relationships with VDU work

In Sweden, a number of epidemiological studies have been performed concerning skin problems and VDU work. In most of these studies, skin symptoms and complaints were more common among those performing VDU work than among those who did not (13, 20, 52, 74, 103). Most but not all of these studies also performed some adjustment analysis for confounding factors. For example, comparing those working at least 20 hrs/week for at least 5 years resulted in a risk ratio of 3.0 (1.2-7.1) according to Berg and coworkers (13). Similar results - an odds ratio of 2.5 (1.1-5.6) for those having worked at least 2.5 man-years - were noted by Bergqvist and Wahlberg (20). Both studies used both a retrospective definition of exposure ("at least 5 years" or "man-years" of VDU work), and a retrospective recall of skin rashes (in the last 2 years, in the last 12 months,

respectively). When asking about current symptoms, only individuals with shorter VDU work duration (<2.5 man-years) indicated a (non-significant) excess odds ratio (2.0; 0.7-5.5) (20). A possible - but in no way definite - interpretation could be that this reflect a transient effect of VDU work, problems appear most commonly at the beginning of VDU work, and then partly disappear. (Compare the description above.) In a longitudinal study, the incidence of reporting skin symptom did not correlate with VDU use vs no VDU use (the risk ratio was 1.2; 0.6-2.3), but did weakly correlate with the intensity of VDU use (>30 hrs/week vs <20 hrs/week, risk ratio=1.9; 0.9-3.8) (19). (The study by Bergqvist and Wahlberg is a cross-sectional part of this longitudinal study.) In a third cross-sectional study by Stenberg and coworkers (101) on office workers in northern Sweden, VDU work was associated with skin symptoms in a dose-response manner (dose = daily VDU work duration); for 0-1 hr/day, the odds ratio was 1.2 (1.0-1.5), for 1-4 hr/day, the odds ratio was 1.9 (1.6-2.2) and for >4 hr/day, the odds ratio was 2.4 (2.0-2.9). These odds ratios were adjusted for other factors (gender, asthma and psychosocial conditions). This large questionnaire study formed the basis for additional investigations, see further below.

In other countries, a few similar studies have been performed as well, with varied results. In some early questionnaire studies from the US with low response rates and limited analysis, one reported an association between symptoms and VDU use (Murray 1981, cf Bergqvist (16) and Stenberg (102), while the other did not (Frank 1983, cf Bergqvist (16) and Stenberg (102). A more recent UK study (23) failed to find a statistically significant association; The odds ratio (calculated by us) comparing VDU and non-VDU users where 1.3 (0.9-1.9). For more specific symptoms or signs, odds ratios varied between 1.1 and 1.7 - none being significant. The low response rate (41%) and the limited analysis should be taken into account.

In a large Italian study (24), both women and men reported significantly higher prevalences of skin disorders and facial rashes when the duration of VDU work exceed 2 hours/day. The odds ratio (calculated by us) was 2.2 (1.6-2.9) for skin disorders and 2.7 (2.3-3.2) for facial rashes. These associations varied somewhat with both age and gender. For example, among women, the odds ratio for facial rash was reduced to 1.4 (1.1-1.7). If a symptom frequency score was used, the associations decreased somewhat, which the authors interpreted as a failure to verify the association between VDU work and facial skin "as have other epidemiological studies...in norther European countries". It may conceivably also reflect the mild type of skin reactions presumably involved. Furthermore, it was noticable that the prevalences of skin rashes and disorders were generally much lower in this Italian study (0.5 - 7%) than among the Swedish studies (see above). To what degree this reflects reality or different manner of ascertainment is not possible to determine. For further discussions of international comparisons of this issue, see also a review by Stenberg (102).

As already indicated, evaluations of skin symptoms, signs and diagnosed skin disorders can be seen as more or less independent processes. For skin signs, Berg

et al. (13) reported a small nonsignificant association with VDU work. Bergqvist and Wahlberg (20) found subtantial increases in the occurrence of non-specific erythema with VDU work, but the limited number of cases again resulted in this excess being statistically non-significant (see further below).

For diagnosed skin disorders overall, the results have been varied, with Berg and coworkers (13) finding an excess (the relative risk was reported to be 1.4; 1.1-1.8 for those working at least 20 hrs/week at a VDU for at least 5 years). In contrast, Bergqvist and Wahlberg (20) did not find such excesses (their odds ratio was 0.9; 0.4-2.2 for those having worked at least 2.5 man-years). For specific diagnoses, however, the correspondence appear greater, both studies noted an increased occurrence of seborrhoeic eczema with increaed VDU use. This is consistent also with the results of some other Swedish studies (63, 104) (Note that the study by Lidén and Wahlberg is based on the same study population as Bergqvist and Wahlberg (20), but 6 years previously.)

Overall, an excess occurrence of subjectively reported skin symptoms or complaints is apparently found among VDU users, whereas a relationship with objective signs or diagnosed skin disorders appear less clear - a case can probably be made for seborrhoeic eczema, and possibly for non-specific erythema. Most - but perhaps not all - of the cases can be described as mild, and many often appear to improve or disappear even without any remedial action being taken. It should be noted that most of the evidence and indications on which these conclusions are based come from Swedish and some Norwegian studies. The information available on studies from other countries than Sweden and Norway appear limited and have produced varied results, even if it can be argued that three out of four studies have at least indicated an excess of problems among VDU users vs non-users. The limited number of non-Swedish publications are perhaps attributable to the more limited attention given this topic in other countries. For example, in the conference series Work With Display Units, which has been held four times (1986, 1989, 1992 and 1994), the dominant presentation on this topic has generally been Swedish).

Relationships between skin problems and electrostatic or low frequency electric or magnetic fields

These fields have been in the center of interest ever since the discussion concerning skin complaints during VDU work commenced at around 1980.

Several investigations have explicitly or implicitly studied the possibility that electrostatic charges on the VDU and/or the operator might influence the occurrence of skin problems. As originally proposed by Cato Olsen (25), the hypothesis would be that increases in the electrostatic field at the VDU work station, or increases in the electrostatic charge of the operators, would increase the facial deposition of small air particles, which in turn might lead to adverse reactions. In an early Swedish study (63), some limited additional support for this hypothesis appeared, but with the emphasis on the operator's charge, not the electrostatic charge of the VDU. Subsequent Swedish studies did not, however, substantiate this; In the study by Sandström et al. the odds ratios for various body

potentials varied between 1.2 (0.6-2.8) and 1.4 (0.7-3.1) (93), while the study by Bergqvist and Wahlberg resulted in an odds ratio of 0.6 (0.3-1.2) for highly charged operators. Neither could the use of grounded filters be shown to reduce the skin problems (21). More recently, two Norwegian intervention studies have, however, somewhat reopened this hypotheses, by indicating a/ that changes in the grounding of an external filter (which affects both electrostatic and low frequency electric fields from the VDU) affected the frequency of tinglings of the skin (77), and b/ efforts to reduce low frequency electric fields as well as electrostatic charges on both the operator and the VDU did reduce the occurrence of skin symptoms - but only in locales with high airborne dust levels (98).

In two Swedish studies, explicit measurements of exposure to low frequency electric or magnetic fields at the VDU work station have been performed - without finding any definite relationship between these fields and the skin complaints (21, 91, 93, 101) after adjustment for other factors, nor with objective signs or diagnosed skin disorders (20, 21). While some excess odds ratios were found between the accumulated exposure (over the years) to line frequency electric and magnetic field, these excesses were shown to be related primarily to the duration of VDU work, not the field levels involved (21). Likewise, an excess odds ratio for ELF magnetic fields (2.7; 1.0-6.9) (93) was reduced after adjustments for other factors (101).

A firmer statistical association was found, however, between electric fields in other parts of the office and the skin complaints in the study by Sandström and colleagues (91, 93, 101). The interpretation of this finding is not straightforward, though. If cases of skin problems increase with increasing VDU work (thus, presumably, staying at the VDU work station), then what mechanism(s) relate this to fields in other parts of the room, but not to those at the VDU work station? One way would be the recognition that measurements of electric fields are extremely difficult and give quite variable results, and that the two parameters measured (VDU vs other places in the room) should be seen as samples of the general level only, and not predictive of specific sites. On balance, this finding is interesting, but can not - in our opinion - be seen as definitive.

Koh and coworkers compared users of CRT (cathode ray tube) and PD (plasma display) VDU users, where the former are generally assumed to cause higher exposure levels - no significant difference was found (53). Likewise, Berg et al. failed to associate their increased VDU work skin rashes with any VDU type or use of filters etc (13).

In summary, the evidence for or indications of an involvement of various electric or magnetic fields on VDU-related skin problems appear weak to almost non-existent. The possible exception is - in our view - actually the first formulated hypothesis, where increased electrostatic charge on (primarily) the operator would increase the deposition of airborne particles, with possible skin-related consequences. If this is indeed the case, then it appears difficult to study, since it would be very situation specific and due to a/ the composition (chemically) of the airborne dust, and b/ the sensitivity of the individual to this dust. This might

explain the failure in some major studies - which did find excess VDU-related skin problems - to find any support for this hypothesis. However, it may then also be argued whether such a situation-specific hypothesis - even if true - is capable of explaining more than a smaller part of the VDU-related skin problems.

Relationships between VDU-related skin problems and some other factors
In the study by Bergqvist and Wahlberg (20), a low relative humidity and skin type were together associated with seborrhoeic eczema; individuals with skin type 1 and 2 who had worked with an average relative humidity below 30% during the preceeding week had an odds ratio of 8.3 (2.5-28) of being given the diagnosis seborrhoeic eczema. This finding appeared to be independent of VDU work, but the occurrence of a low relative humidity was more common in locales where VDUs were placed. The authors tentatively ascribed the earlier reported findings of associations between seborrhoeic eczema and VDU work (20, 63) to low relative humidity as an alternative explanation.

In an intervention study, a high air temperature (above some 23 °C) increased the reporting of various skin symptoms (especially among men) (49). Further limited support for such associations can be found in the seasonality of some skin problems, e.g. for seborrhoeic eczema (104). In contrast, no real associations with humidity or air temperature was found by Sandström and coworkers (91, 93), but the fact that the climate factors and skin problems were not ascertained in the same time periods may be a possible explanation for this non-positive finding.

Overall, VDU-specific studies have given some limited indications that a low relative humidity and/or a high indoor air temperature is conducive to certain skin ailments. If so, and if some observations are correct that put these findings as basically independent of VDU work (but mixed because of common occurrence of these problems in VDU localities), then some of the skin problems ascribed to VDU work situations may in actuality be involved in the "indoor air problems" also discussed.

A high workload was shown in two studies (20, 101) to be associated with skin symptoms. In e.g. the former, an odds ratio of 3.7 (1.3-10.3) was found, after adjustments for other factors. In the latter, a relationship was also noted between workload and the objective sign of nonspecific erythema. This latter relationship was noted among VDU users only, though (20). Likewise, Norbäck and coworkers (74) also noted some fairly strong - but uncertain - relationships between dermal problems and various psychosocial factors.

In this part of the review, no effort was made to describe the totality of scientific evidence connecting indoor air climate or stress factors with skin problems - the review is limited to studies which specifically have investigated these associations in VDU situations. Generally, a fairly large body of evidence connect these factors with skin problems - evidence obtained in other situations. The studies reviewed here are - in our opinion - sufficient to indicate that generally accepted factors for skin complaints such as low relative humidity/high indoor air temperature or stress are operating also in VDU work situations, and to

at least suggest that these may actually be major explanatory factors for the noted association between VDU work and skin ailments.

Summary - VDU work and skin problems
In summary, while skin symptoms appear to be associated with VDU work, this appears less certain for skin disorders. Regarding objective signs, no conclusion appear possible. Some results suggest that "normal" explanations for these problems such as a low relative humidity or a high air temperature, as well as stress situations, may be major explanatory facors for these skin problems also in VDU work situations. In contrast, suggestions of electric or magnetic field involvement are very scant to nonexistant. One possibility could, however, be static charges leading to a higher facial deposition of skin irritants.

These conclusions are almost exclusively derived from Swedish and a few Norwegian studies. The degree by which they are applicable to skin problems among VDU users also in other countries is not clear - nor is indeed the occurrence of the problem there. It is conceivable that major effect modifiers such as the prevalence of low relative humidity situations or differences in skin types etc. may play a role in causing large scale regional differences.

Finally, it should be reemphasized that these skin problems - often of mild and transient character - should not be mixed with the less common occurrence of individuals with more severe health problem being attributed to various "electrical sources". See further next section.

Reactions among individuals with possible special sensitivity

In the section above, data concerning associations between various but often rather common symptoms and electric or magnetic fields were examined. It was found that the evidence for such associations - although some indications needing further investigations do exist - was rather meagre. For these studies, study populations were normally recruited among the general population, and the evaluation was based on statistical methods. It is thus conceivable, that if a higher sensitivity to a specific factor exist among a small group of individuals, then these studies reviewed above may be incapable of detecting associations between the factor such as field exposure and symptom in such (hypothetically) few sensitive individuals. To overcome this possible problem, studies are warranted that specifically look at such sensitive individuals, but in order to do so, they must of course first be identified.

Aim

This section examines the evidence for the existence of groups with special sensitivity that could be of relevance to "electrical sensitivity". Such sensitivity could be defined around a self-declaration of sensitivity, an explicitly measured sensitivity to an external factor, a type of reaction, an individual/constitutional

factor or a personal trait. When reviewing such different bases for "sensitivity", other data pertinent for the particular type of sensitivity (if any) are also discussed.

Groups defined by self-definition, symptoms and/or attribution

The simplest and ostensibly most straightforward approach would be to identify an individual as "electromagnetic hypersensitive" based on his/ her own appraisal. It can be shown, however, that this approach does have serious drawbacks in terms of scientifically valid methodology: Such a definition of effect will involve also an appreciation of the exposure - and if that is related to the real exposure, false positive results may be obtained when examining the possible association between "electromagnetic hypersensitivity" and the exposure. However, in the absence of the individual being able to determine his/her "exposure" situation, this self-definition approach may still be valid.

Several attempts have been made to describe typical symptoms of individuals claiming to be "electromagnetic hypersensitive". Symptoms have also - in a few instances - been used to define possible subgroups. In an early case series description of 32 seriously afflicted individuals (51), they were differentiated as to:

- Individuals with symptoms dominated by skin problems. This subgroup reported their problems primarily in terms of VDUs or VDU work, and could be described as having a fairly good prognosis - various efforts to improve the situation appeared to work for many of them.
- Individuals with symptoms dominated by neurasthenic problem (but often also with skin problems). This subgroup attributed their problems to a range of electrical appliances (including VDUs), and their situation did not seem to respond as well to remedial actions.

Bergdahl and coworkers (14) differentiated a group of 20 individuals according to their own attribution of their problems; a/ the "VG" group - only to VDUs and fluorescent tubes or b/ the "EG" group - to a wide range of electrical devices. When symptoms were ascertained, the results were found to be similar to those given by Knave et al. above, as the VG group reported primarily skin symptoms, while the EG group also reported a number of neurasthenic symptoms (dizziness, headaches, concentration problems, heart palpitations etc.). (See further below for a psychological profile of these individuals.)

In another recent study based on questionnaires (111), 111 individuals who were all still actively employed (although some were on sick-leave for various reasons) declared themselves as "electromagnetic hypersensitive". Based on their symptoms, they were divided into four groups:

- 67 individuals (60% of the case group) who considered themselves "electromagnetic hypersensitive", each individual reported, however, few if any skin or neurasthenic symptoms,

- 26 cases (24%) reported several skin symptoms,
- 9 cases (8%) reported several neurasthenic symptoms, while
- 9 cases (8%) reported both several skin and neurasthenic symptoms.

It should be noted that a number of individuals who did not consider themselves as "electromagnetic hypersensitive" were also found in all subgroups. One obvious possibility is to use symptom-based groups as the basis for further investigations, regardless of self-declaration of "electromagnetic hypersensitivity". A few cautionary comments are warranted, though. First, this might miss - as previously argued - a (hypothetical) special groups which otherwise might be "drowned" in others. Possibly reinforcing this, it was noticed that - within this study - there were differences between e.g. the skin subgroup derived from the cases and from the non-cases (111). Furthermore, this strictly symptom based approach has actually already been reviewed (see the section on skin problems above).

Eriksson (32), reporting on the same study as Sandström, Stenberg and coworkers, noted that during the 5-year follow-up period, individuals who, in addition to having skin symptoms, also reported other symptoms (general or mucosal) had a higher risk of still having skin symptoms five years later. This finding appear to be consistent with the retrospective information obtained from Knave et al. (above) - a better prognosis for individuals with (primarily or only) skin symptoms.

Thus, care should be taken for the heterogeneity of those calling themselves "electromagnetic hypersensitive". Data above, which are all from Sweden, do clearly indicate this - at least for the Swedish situation. Tentatively, a VDU/skin oriented group could be differentiated from other group(s) with a more diverse attribution and with a higher occurrence of (also) neurasthenic symptoms. It should be emphasized that this more diverse attribution (at least in Sweden) still includes VDUs. For example, in a study reported in 1988 by Berg on 201 referred patients for suspected VDU-related skin problems (9), 5 individuals (2.5%) declared themselves sensitive to electricity ("electric allergy"), they were described as having different symptoms, and reported limitations of their daily life. (See further below.)

Individual and possibly predisposing factors

Hormonal levels and stress mediated reactions

Arnetz and coworkers (3, 11) examined 47 office workers with VDU associated skin symptoms (19 cases) or 28 healthy controls, and found that the cases differed from the controls during actual work with VDUs but not during leisure days (both situations were apparently in the same locales, so as to keep the "electromagnetic environment" constant). The following differences were found:

- Higher hormone levels (prolactin and thyroxine) among the cases than the controls, but only during a working day. A similar decrease was found for